WATER QUALITY ASSESSMENT FOR LAKE BLACKSHEAR, GEORGIA

Lisa Jan Broadhurst[1] and Elisabeth D. Elder[2]

AUTHORS: [1]Student and [2]Department Head, Biology Department, Georgia Southwestern State University, 800 Wheatley Street, Americus, GA 31709.
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Abstract. Lake Blackshear, a man-made impoundment of the Flint River, is used extensively for recreational activities as well as for power generation. The purpose of this study was to monitor water quality in two representative areas of the Lake, Spring Creek and Warren Slough. Samples from seven locations were collected four times each month from December 1999, through December 2000. Samples were monitored for total coliforms and fecal coliforms with the most probable number method and for heterotrophic plate counts with nutrient agar. *In situ* determinations of temperature, dissolved oxygen, and pH were made respectively with an YSI meter and a pHTestr2. Seasonal variations, high temperatures with low dissolved oxygen during summer months and lower temperatures with higher dissolved oxygen levels in winter months, were observed. The pH remained relatively constant throughout the study period. Spatial and seasonal variations occurred in the bacterial counts but coliform counts generally met Georgia requirements for recreational and fishing waters.

INTRODUCTION

Lake Blackshear is an impoundment of the Flint River located approximately 20 miles southeast of Americus, Georgia, on the Sumter-Crisp County Line. The building of a power dam in Warwick, Georgia, in 1929 formed the body of the lake. The pool of the lake remained relatively stable until the dam was broken by a flood in the summer of 1994. The Lake was refilled within an 18-month period and has remained relatively stable. Lake Blackshear lies within the Upper Coastal Plains area but half the drainage area is in the Piedmont and Fall Line transition areas (Tietjen and Cofer, 1999). While the Piedmont area does have agricultural uses, these are greater in the Coastal Plains portion of the watershed (Tietjen and Cofer, 1999). In addition to agricultural use, some 1800 residences, 70% occupied year round, surround the Lake (Tietjen and Cofer, 1999).

With the extensive use of the Lake for recreational and fishing activities, water quality is critical. An extensive water quality study was undertaken prior to the flood of 1994 (Tietjen and Cofer, 1999). This study was undertaken to check current quality of the Lake. Spring Creek and Warren Slough were selected as representative areas of the Lake in terms of land use and development. Spring Creek, a tributary entering the southwestern quadrant of the Lake, drains an area used in grazing cattle, for crops such as cotton, and is surrounded by residences with septic systems. Warren Slough, an embayment off Spring Creek, surrounded by residences with septic systems, was selected in that it had higher fecal coliform counts in the earlier water quality study (Tietjen and Cofer, 1999).

MATERIALS AND METHODS

A total of seven sampling sites were selected in Spring Creek and Warren Slough. Samples were collected four times a month (DNR, 1999) via canoe, six inches below the surface with sterile screw cap 190 ml bottles. Samples were iced for transport and processed within two hours.

All parameters were monitored with standard procedures (APHA, 1992). Total and fecal coliforms were monitored with the five tube most probable number procedure, and geometric means were recorded for each month. For heterotrophic plate counts, serial dilutions were made in sterile peptone water, and used to inoculate triplicate spread plates of nutrient agar, which were incubated at room temperature. Arithmetic means were recorded for each month. Counts were made after 5 and 6 days of incubation with the higher count recorded. This technique is the same as Standard Methods (APHA, 1992) with the exception of nutrient agar for plate count agar. Plate count agar was not used because preliminary samples showed that nutrient agar resulted in more reproducible counts.

The chemical/physical parameters were monitored *in situ.* Each measurement was made 6 inches below the water surface. Temperature and dissolved oxygen were determined with an YSI meter that was calibrated prior to each trip with membrane replaced on a monthly basis. A pHTestr2, calibrated prior to each trip, was used to determine pH. Monthly arithmetic means were calculated for temperature, dissolved oxygen, and pH.

RESULTS AND DISCUSSION

The results obtained were compared with standards established by the State of Georgia (DNR, 1999) for recreational and fishing areas. Georgia statutes specify collection of four samples, within a 30-day period, used to calculate geometric or arithmetic means. The state of Georgia does not have set requirements for total coliforms. For recreational waters the geometric means for fecal coliforms cannot exceed 200/100 mL. For fishing waters, the statutes vary with the season. From May through October, the geometric means for fecal coliforms cannot exceed 300/100 mL. From November through April the geometric means for fecal coliforms cannot exceed 4000/100 mL. The statues for the remaining parameters monitored in this study were based on arithmetic means for both recreational and fishing water. The range for pH is 6.0 to 8.5. Temperature should not exceed 90° F or 32.2° C. Dissolved oxygen should be a daily average of 5.0 mg/L and not fall below 4.0 mg/L.

As shown in Table 1, total coliforms were generally low, with most ranging from 100/100 mL to 150 cfu/100 mL. Highest total coliforms were at Spring Creek 4 in February at 269 cfu/100 ml and at Spring Creek 1 in April at 200.0 cfu/100 mL. Lowest total coliforms occured at Spring Creek 4 at 22 cfu/100ml in March. Warren Slough 1 appeared to be the area with the least amount of total coliforms. Spring Creek 1 had the highest total coliform levels in that it had elevated values for all the sampling months except for February, while Spring Creek 4 had the highest value overall, it had less elevated levels throughout the other months of the study.

As shown in Table 2, fecal coliforms only exceeded the state standard for recreational use (200 cfu/100 ml) during February at Spring Creek 2 with a value of 231 cfu/100 ml. This value was not high enough to exceed fishing statutes of 4000/100 mL for the winter season. The low for fecal coliforms was 34 cfu/100 ml at Spring Creek 3 in March. Values for fecal coliforms were generally below 100 cfu/100 mL for most sites. These lower values show that there was less fecal pollution than other types of bacterial pollution. The least polluted area was once again Warren Slough 1, while Spring Creek 1 had the highest levels again. Fecal coliform levels in Warren Slough were lower than levels, 265 cfu/ 100 mL, obtained in the earlier study (Tietjen and Cofer 1999.) Also neither the high nor the low for fecal coliforms coincided with the high and low for total coliforms.

As shown in Table 3, the heterotrophic plate count numbers were low in December and January but climbed to a high in February with the exception of a high in December at Spring Creek 1. In May, a fungal overgrowth prevented counting of bacterial colonies. The counts stayed relatively stable for the rest of the study with the exception that Warren Slough 3 had higher numbers than the others from June to August.

The temperature ranged from 10.7° C in February at Spring Creek 1 to 28.6° C in August at Spring Creek 4. The low in February was consistent since the earlier study had a mean temperature of 10.86° C for February (Tietjen and Cofer, 1999). The high in August was attributed to higher temperatures and stratification of the lake normally seen during the summer months (Tietjen and Cofer, 1999). Even though the samples were not taken at the surface but six inches from the top, this layer does not mix with the lower cooler water and thus radiation continues to increase the temperature of this water. All temperatures were within the standards for Georgia.

The dissolved oxygen ranged from 4.8 mg/L at Spring Creek 1 in July to 11.8 mg/L in February. The low was attributed to high temperatures, as oxygen is less soluble in warmer water that it is in cooler water. Seasonal stratification can also play a minor role in the low in July. The only time the Lake mixes during the summer to move more oxygen to the lower levels of water during a summer storm. Summer storms were infrequent during the summer months of the study. The values for dissolved oxygen are within state statutes.

The pH ranged from 7.5 in August to 8.4 in December. The pH values remained stable throughout the study and are well within the normal range for Georgia standards.

In the results for total coliforms, fecal coliforms, and heterotrophic plate counts, all showed a high in February. Low temperatures and a high in dissolved oxygen may have favored total and fecal coliform levels being higher. Heterotrophic plate counts were higher based on the fact that higher total and fecal coliform levels means more overall bacteria in the Lake.

Table 1. Geometric Means of Total Coliforms (cfu/100 ml) in Lake Blackshear Samples Collected December 1999, through November 2000

Site[1]	Dec	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.
SC1	152.9	35.2	139.2	131.6	200.0	82.5	162.6	95.7	84.1	126.0	95.5	88.3
SC2	143.1	108.5	161.9	127.0	110.6	61.2	77.6	72.7	49.5	98.6	61.2	95.7
SC3	40.9	80.0	112.3	34.1	147.1	49.0	98.8	88.0	47.6	83.0	45.2	92.0
SC4	53.3	76.2	268.8	21.9	105.0	93.0	71.4	51.3	55.9	84.2	55.4	65.4
WS1	53.6	18.9	112.0	53.3	77.4	60.8	56.9	68.1	48.4	90.0	62.6	53.0
WS2	58.9	52.8	114.7	51.2	90.7	38.7	117.8	72.1	87.7	98.8	85.5	53.8
WS3	56.2	48.0	109.2	74.9	56.2	53.6	119.0	83.2	133.0	137.0	60.5	53.8

[1] SC1-SC4 indicate stations on Spring Creek; WS1-WS3 indicate stations on Warren Slough

Table 2. Geometric Means of Fecal Coliforms (cfu/100 ml) in Lake Blackshear Samples Collected December 1999, through November 2000

Site[1]	Dec	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.
SC1	164.9	42.9	104.0	110.9	188.2	57.9	153.1	95.7	97.2	90.0	95.5	88.3
SC2	73.9	63.1	230.6	127.0	62.1	49.2	67.2	60.3	65.3	106.6	61.2	95.7
SC3	53.9	36.9	83.0	34.1	139.1	42.5	85.3	88.0	47.6	79.1	49.5	92.0
SC4	29.3	40.7	159.8	40.8	65.5	71.5	71.4	63.0	46.0	79.1	55.4	65.4
WS1	43.1	38.0	72.9	44.4	77.4	48.9	55.4	60.5	49.2	90.7	62.6	53.0
WS2	80.7	37.8	85.7	41.5	83.8	37.8	71.7	81.0	136.7	97.8	75.3	53.8
WS3	57.9	65.9	70.8	63.0	55.9	43.2	100.0	83.2	141.1	98.8	60.5	50.4

[1] SC1-SC4 indicate stations on Spring Creek; WS1-WS3 indicate stations on Warren Slough

Table 3. Arithmetic Means of Heterotrophic Plate Counts (cfu/ml) in Lake Blackshear Samples Collected December 1999, through November 2000

Site[1]	Dec	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.
SC1	1.4E+04	5.0E+03	1.5E+04	5.8E+03	3.4E+03	N/A	2.0E+03	2.0E+03	2.1E+03	1.4E+03	7.9E+02	2.3E+03
SC2	2.5E+03	3.4E+03	2.0E+04	7.9E+03	9.5E+03	N/A	1.0E+03	1.3E+03	1.3E+03	7.3E+02	5.2E+02	2.7E+03
SC3	2.0E+03	4.5E+03	1.6E+04	5.8E+03	4.3E+03	N/A	1.1E+03	1.7E+03	8.1E+02	9.5E+02	1.8E+03	2.8E+03
SC4	2.3E+03	4.7E+03	1.7E+04	8.3E+03	5.7E+03	N/A	1.0E+03	1.4E+03	1.4E+03	9.9E+02	4.5E+02	1.8E+03
WS1	2.7E+03	4.7E+03	1.9E+04	7.3E+03	6.5E+03	N/A	1.0E+03	1.1E+03	9.3E+02	9.0E+02	6.4E+02	1.7E+03
WS2	2.5E+03	5.3E+03	1.4E+04	5.3E+03	1.8E+03	N/A	2.6E+03	2.8E+03	6.3E+02	5.1E+02	2.7E+03	1.2E+03
WS3	2.7E+03	3.7E+03	1.1E+04	3.8E+03	9.0E+03	N/A	7.4E+03	7.0E+03	1.6E+03	1.5E+03	9.2E+02	1.0E+03

[1] SC1-SC4 indicate stations on Spring Creek; WS1-WS3 indicate stations on Warren Slough

CONCLUSIONS

In general, the Spring Creek and Warren Slough areas of Lake Blackshear were in good chemical and physical condition. There was relatively little bacterial pollution from the agricultural use and housing development of the watershed. It can be concluded that the Lake as a whole is in good bacterial shape for recreation and fishing. With the change in the fact that Warren Slough was less contaminated than Spring Creek, it can be surmised that a possible problem with septic tanks is no longer a problem since the flood of 1993. The health of the lake could change at anytime as practices in agriculture and building change. These changes in practices should be monitored carefully as the Lake is an important resource for all that live in the surrounding area and must may taken care of to ensure its continued existence and use by humans and wildlife.

REFERENCES

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